developing it. They said they'd do it, and we've had the product on the market for about three years now."

That product is the Spiker Overseeder made by the T.I.P. Company in Stevens Point. "It's used for penetrating the green when overseeding," Vince explains. "We wanted something that would not disturb the green and would lead to better grass seed germination. So far, we've been very happy with the results. And we're beginning to get national recognition with it now."

In addition to the Spiker Overseeder from T.I.P., Vince also distributes turf equipment for Terra Care Products, the Kromer Co., and Greens Groomer World-Wide. And he carries a complete line of pruning tools from the Michael's Company.

Proud supporter . . .

Vince participates and takes pride in the golf industry. "I'm a very avid supporter of the WGCSA, the WTA, the OJ Noer Research Facility, the Northern Great Lakes GCSA, and the GCSAA," he points out. "I really believe strongly in what these organizations do. Their research, their symposiums. It's so important because we all need to continue to learn. I do. If I wasn't learning anything, something would be wrong."

He also enjoys his association with golf course superintendents. "I think if I knew some 30 years ago the relationship that I'd develop with the golf course superintendents and their crews, I would have gone into this business 30 years ago," he says . "There's such a relationship here with the people. They're not just my customers. They're friends. I do things with them, like play golf. Where else can you have a relationship like that?"

Those relationships mean even more to Vince since he lost his second wife, Alice, in May of 1998. "It was a devastating loss for me," he admits. "Our kids were all gone so it was just the two of us. We did everything together. It's taken time to heal. But life has to go on. We had a wonderful life together."

Vince has four children from his first marriage, and Alice had four children from her first marriage. So Vince now has eight children, 17 grandchildren, and three great-grandchildren scattered across the country.

For a man whose vocation is also his avocation, Vince doesn't have too many interests that aren't connected to his work. "I'm a lousy golfer, but I still love to play golf. I play with guys I enjoy being with," he points out. "And I do fish. I was an avid ice fisherman at one time. I fished whenever I could until I moved up here to Wisconsin. I still fish, but nothing like I used to."

Since his early days working on Chicago area golf courses, Vince has seen a lot of changes in the industry. The biggest of those changes is the number of courses. "I can't even begin to imagine the number of golf courses that are being built or being contemplated," he says. "I hear people say they're being overbuilt. But I also see all these baby boomers who are playing golf now – and a lot of them are playing. When they retire in a few years they're going to be playing a lot more golf.

"I see the future of the golf industry as just going crazy," he continues. "One of these days I can sit back and say, 'Man, oh man, I'm sure glad I was a part of this."

Vince, sit back and not be a part of it all? We'll see.

My Putting Green Grow-In Program

By Dr. Wayne R. Kussow, *Department of Soil Science, University of Wisconsin - Madison*

If you are not a regular attendee of the annual Wisconsin Golf Turf Symposium, you're losing out on one of the most unique educational experiences in the U.S. The amount of information provided in $1\frac{1}{2}$ days is unsurpassed by any other conference, seminar, or symposium that you might attend.

What really grabbed my attention this year was the 10-week grow-in strategy for bentgrass putting greens. I don't doubt but that it can be done if weather cooperates and, as recommended, you begin the process on or about August 1. As I'm sure you've already guessed, the strategy presented has me concerned. I'm not sure everyone picked up on some of the nuances of the strategy that can be crucial to its success.

According to my notes, the strategy went something like this. Use starter fertilizer and something like 15-0-30 to apply about 5 lb N, 7 lb P (16 lb P_2O_5), and 1.4 lb K (1.7 lb K_2O) preplant. Seed, dimple, and start irrigating 2 to 4 cycles of the irrigation heads every couple of hours during the day. Start mowing at 0.250 inch as soon as the bentgrass reaches the two to three-leaf growth stage. Start applying 1 lb N/week, much of it as starter. Topdress weekly and slowly drop the mowing height so you are at 0.156 inch at the end of 10 weeks. At that time, you will have applied a total of about 13 lb N, 16 lb P, and 5 lb K and the green is grown in.

My concerns with this strategy begin with the notion that after 10 weeks, grow-in is complete and the putting green is ready for play. As pointed out by Dr. Stier, it takes 12 weeks or more for bentgrass plants to mature. James Moore further expressed the view that the putting green is not ready for play until it

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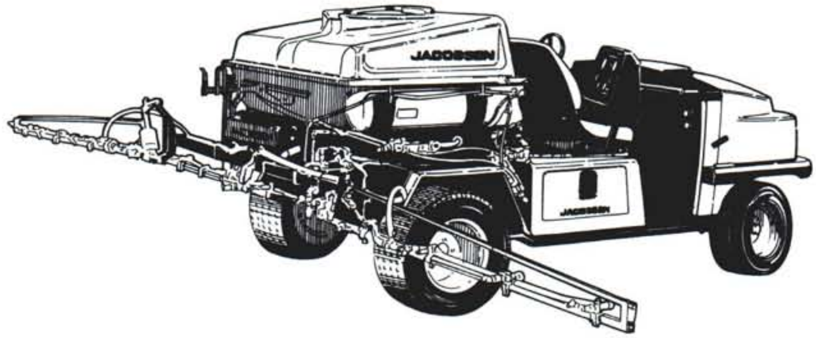

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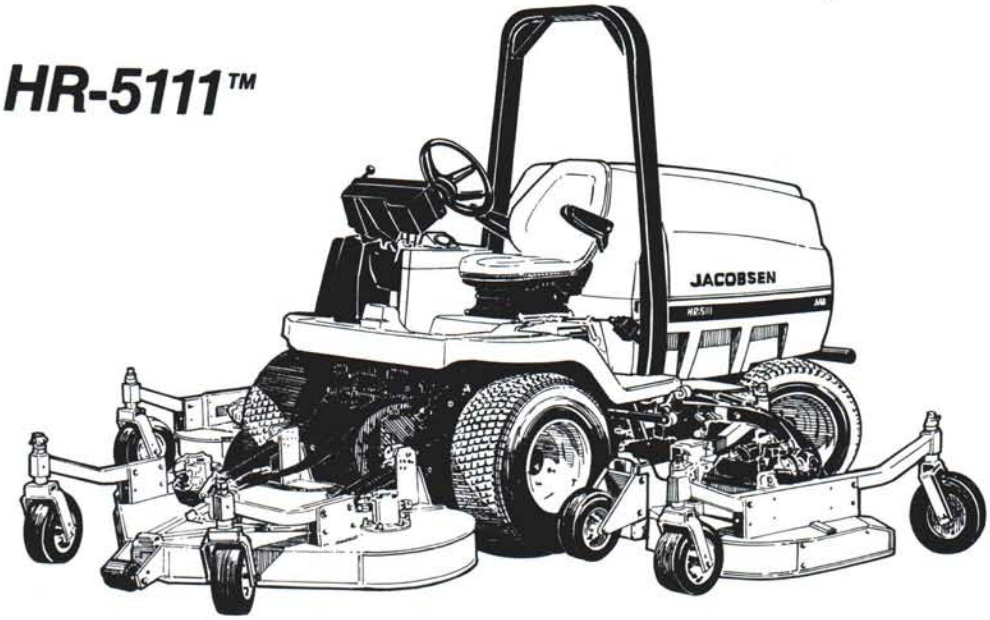

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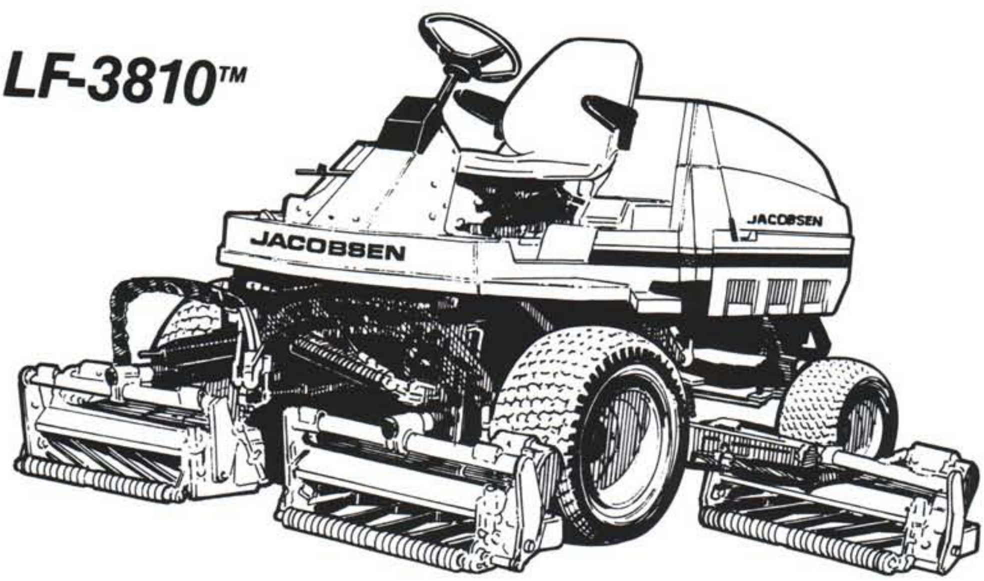

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has a mat 1/8-inch thick or more to cushion the juvenile bentgrass and protect its crowns from physical damage. From either perspective and my personal experience, a 10-week-old putting green is not ready for play, particularly if growth of the bentgrass has been forced to the maximum by excessive N rates. My condolences to any superintendent that is forced to open greens for play after a 10-week grow-in period!

A second concern is one that Jim Moore touched upon very lightly, but merits stronger voicing. There is absolutely no way that creeping bentgrass or any other grass can begin to utilize more than a fraction of the 13 or so pounds of N applied over 10 weeks. There is sufficient information in turf literature for me to state that once the N rate exceeds about 0.2 lb/week on turf with complete ground cover, the N leaching rate becomes excessive and poses an environmental hazard. I had the opportunity to analyze drainage water from Lambeau Field when the grow-in N rate was 1.0 lb N/week. The water contained 43 ppm nitrate-N. This is more than four times higher than the allowable concentration in drinking water.

A third concern is that not everyone at the symposium picked up on the recommendation that all fertilizers applied be homogeneous and less than 50% of the N in the fertilizer be water-soluble. An immediate reaction to this is to think that the reasons are to reduce N loss via leaching. I have some reason to believe that something else is involved here. It will vary with the quality of the irrigation water, but I believe the fertilization rates advocated are pushing the limit on soluble salts. This belief arises from some strange results I got one time when applying 0.8 lb N/week during grow-in on a simulated putting green in the greenhouse. The bentgrass became chlorotic, stunted, and thinned out. The problem was only resolved by leaching the putting greens with 2 inches of water.

A fourth concern is what type of root system one has on a putting green grown as described at the symposium. What is the superintendent inheriting? My casual observation is that if you do not achieve extensive root growth during grow-in, it is very hard to achieve once the green is brought into play. A much easier task is that of maintaining a good root system. On one of our experimental putting greens that had roots the full depth of the root zone mix after grow-in and was subjected to a mowing height of 0.125 inch and traffic that simulated nearly 40,000 rounds of golf ended the season with rooting to a depth of 10 inches.

A fifth concern is the extensive use of slow-release N during grow-in. The superintendent that takes over management of the green had better be prepared to live with a reservoir of slow-release N whose effects are going to be seen for many months.

Through a series of greenhouse studies, I developed what appeared to be an effective, biologically rational, and environmentally safe putting green grow-in program. I tested some of my ideas when growing in a green in 1997. The seeding date was May 6. By September 7, the green was being mowed at 0.156 inch, the uniformity of the bentgrass stand was superb where I did not allow P deficiency to occur, the roots were growing through the intermediate sand layer, and the green was firm but resilient enough for play to begin.

My strategy was very different from that presented at the symposium. I started out with a pre-plant application of starter fertilizer at the rate of 1.5 lb N/M. The bentgrass seed was blended with Milorganite in a ratio such that putting down 1.8 lb/M seed included 0.4 lb N. The initial mowing was at 0.5 inch and took place as soon as the bentgrass achieved this height. An N fertilization program of 0.2 lb N/week was then initiated with the "magic" ingredient, feed-grade urea. I feel that use of urea allowed me to maintain control over the bentgrass growth rate and keep it reasonably uniform over time. In essence, I used the "spoon feeding" approach, putting down only as much N as I felt the grass could effectively utilize. During grow-in, there must be a healthy supply of P to ensure good root growth. This can be achieved with monthly application of 0.5 lb P/M as starter fertilizer.

The mowing height was dropped in 0.0312 (1/32)-inch increments. If there was any sign of scalping, the mowing height was immediately raised until the green could be sand topdressed. The first topdressing of the green was heavy about 1/3 inch. Thereafter, the rate varied between 1 and 2 ft3/M. A total of six topdressings were applied during grow-in.

And there you have it – my putting grow-in program.

The Science and Management of Turfgrass Winter Injury

By Dr. Frank S. Rossi, Cornell University

*Editor's Note: A familiar author appears here - Frank Rossi, Cornell University Turfgrass Team Member and former UW-Madison faculty member. This article originally appeared in Vol. 9, No. 3 of **CUTT** - Cornell University Turfgrass Times. Frank's interest in winter injury is still strong; New York State can experience vast areas of intense winter weather. I have permission from both the author and from the editor of **CUTT** - they are one in the same. He sends greetings to all.*

Each year acres of turfgrass across the northern regions are affected by winter injury. In some cases the injury can be severe and lead to "winterkill:" turf death resulting from singular or combined effects of freezing stress, ice encasement, traffic, desiccation, soil frost heaving, and low temperature fungi. Many of these factors, such as ice encasement or species susceptibility to freezing stress, are not easily managed.

Extensive turf loss can have significant environmental and economic consequences on the functional and aesthetic quality of recreational turf areas. Turf loss from winter injury, most evident in the spring, results in increased weed encroachment, greater soil erosion, and often requires energy intensive reestablishment procedures to restore the environmental benefits of a contiguous and healthy turf cover.

Low Temperature Acclimation

Survival of perennial vegetation such as turfgrasses, trees and other species that persist in northern climates requires adjustments in growth in response to day length and temperature changes. These adjustments (acclimation mechanisms) that are required for winter hardiness can begin to occur in mid- to late summer. This fact is easily proved when bentgrass plants are taken from the field in June, they are easily killed at about 32 degrees F, while plants taken at peak hardiness in early January can survive down to -35 degrees F.

Maximizing energy production from photosynthesis is essential for winter hardiness. The plant produces energy from photosynthesis and utilizes a portion for additional biomass (leaves, roots, etc.) then begins to store energy for the winter.

Energy storage is vital for winter survival for several reasons. The first and most important reason is that while the plant in dormant, it continues to respire (burn) energy. It is similar to when we sleep: we continue to breathe, we just breathe differently (deeper, more slowly). Therefore the plant must have the necessary energy to respire or it will be more susceptible to diseases and other stress.

The next important aspect of acclimation has to do with cell membranes. The membrane structure is altered in a similar fashion as it does when a plant enters dor-

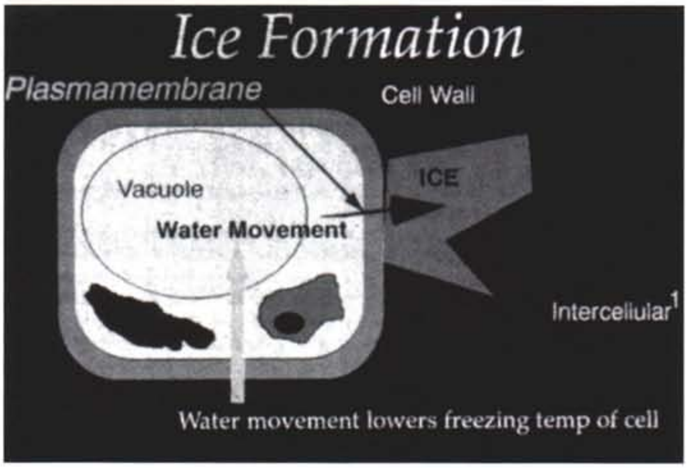

Fig. 1

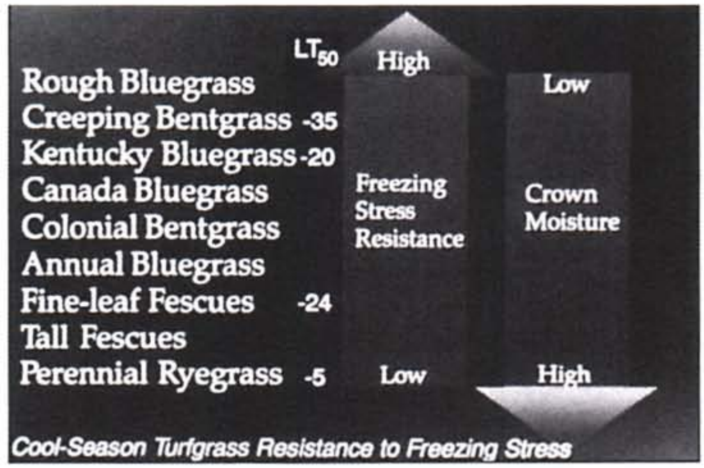

Fig. 2

mancy from moisture stress. In fact, studies have shown with some plants that slight moisture stress during acclimation can enhance winter hardiness. Also, there appears to be a requirement for certain turfgrasses to experience primary acclimation following freezing temperatures around 32 degrees F, then secondary hardening when temperatures fall into the 15 degree to -25 degree range.

Ice Formation Within the Plant

Plants that are most successful in surviving winter are able to tolerate ice formation between the cells. On extremely rare occasions, ice will form within a cell, if temperatures drop rapidly, however for grasses this is thought to be a minor issue. Rather, it is the formation of ice between cells that draws water from within a cell and results in desiccation (see Figure 1).

The phenomenon of crown hydration is a result of excessive cell dehydration. For example, during the most sensitive period from late winter through early spring when most winter injury occurs, freezing and thawing temperature fluctuations prevail. If the turf is saturated, in standing water, or a blackening agent is applied and allowed to accumulate and absorb heat, that heat is transferred to the plant and growth is stimulated. When growth is stimulated, the tissue fills with the water that drives growth (cell expansion). That water is now available for freezing when the temperature drops. As the ice begins to form between the cells, the crystals "draw" water from inside the cell and cause cell death.

Researchers have speculated for years that one of the single most important aspects for enhancing winter hardiness is delayed de-acclimation or breaking of dormancy. This is most difficult with annual bluegrass that is likely to break dormancy rapidly in the spring. In fact, researchers at the Prairie Turfgrass Research Center have quantified the reduced hardiness of annual bluegrass following 8 hours of temperatures above 40 degrees F. It was concluded that freezing tolerance was reduced 5 - 10 degrees F following that slight warming.

It is important to understand a few of these basic principles, because they assist with determining the most effective management program for ensuring survival. Still, winter hardiness is extremely dependent on the species of turf growing (see Figure 2). Creeping bentgrass is one of the most winter hardy species, while annual bluegrass is one of the more susceptible. Perennial ryegrass and tall fescue can be marginally hardy in the northern climates in the first few years following establishment. Mature stands can be more winter hardy, especially if the soils are well drained and the area is somewhat protected.

Ice Encasement

As indicated previously, turfgrasses continue to respire energy throughout the winter. This physiological process requires gas exchange. Therefore, when winter conditions result in ice formation on the turf surface, the necessary gas exchange cannot occur and the area beneath the ice becomes anaerobic (lacks oxygen). In addition, there are substantial amounts of gas given off from the soil as some microbes remain active, such as the snow mold organisms.

The cool-season grasses have varying abilities to tolerate ice encasement. For example, under research conditions, annual bluegrass can survive up to 60 days under ice, Kentucky bluegrass 100 days and creeping bentgrass 150 days. This is probably consistent with most turf managers' experience with the regular loss

of annual bluegrass under winter conditions.

Severe incidents of ice encasement are sporadic, occurring one out of every three to five years in most northern regions, and management can be difficult. Yet, the key to alleviating the problem is simply to break the ice to allow adequate gas exchange (see Figure 3). This can be accomplished by physically disrupting the ice. Several turfgrass managers have utilized core cultivation equipment fitted with solid, "hammer-like" tines to break the ice. Still, the use of a "blackening agent" such as dark compost or natural organic fertilizers, such as Milorganite, applied to the ice surface on bright days absorbs heat and creates pores in the ice that allow for gas exchange.

Fig. 3

Unfortunately, ice encasement is not the only challenge from this phenomenon. During the transitional period between late winter and early spring when freezing and thawing can occur, the plants experience warm, saturated conditions. These conditions, described earlier in this article, can lead to freezing stress, where ice forms within the plant, causing severe cell dehydration. Again, this argues for adequate surface drainage as a means of minimizing this problem.

Factors that Influence Hardiness

Drainage. One of the most critical aspects of winter injury whether it is ice encasement, snow molds or crown hydration (cell dehydration) is free water for freezing to encourage disease. In addition, wet fall periods prior to winter will reduce winter hardiness. The importance of proper surface drainage cannot be stressed enough, especially on turf areas such as athletic fields and golf greens that are trafficked in the early spring.

Fertility. For the grass plant to maximize photosynthetic activity, adequate, well balanced nutrition must be available. In fact, many studies have shown increased energy (carbohydrate) storage following late fall fertilization. Products that have a high percentage of water soluble nitrogen are ideal for this purpose; however, on sandy soils, care should be taken to use more moisture dependent slow release materials such as IBDU to ensure water quality.

The late fall fertility is best applied after top growth has ceased which typically coincides with seven to ten days when the mean daily average temperature is 50 degrees F. This ensures that any warming periods that might stimulate top growth (Indian summer) and reduce hardiness have passed. There is usually a period from late September through late October, depending where you are in the north, when fertilizer should not be applied.

Many turf managers apply excessive amounts of potassium (K) in the late season to enhance winter hardiness. Keep in mind, there is no conclusive evidence that indicates K levels above that which is required for adequate growth (indicated by soil test) will enhance winter hardiness. Furthermore, there may be severe consequences from excessive application of high salt content fer-

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